NASA LaRC
Thermal Testing Philosophy

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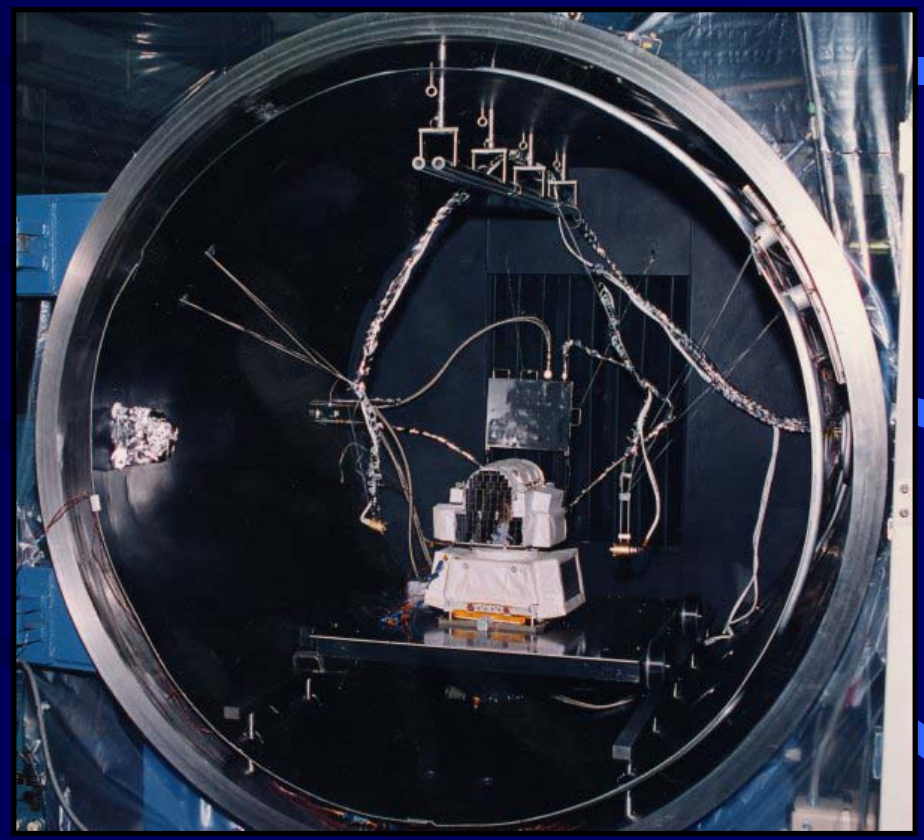
LaRC Testing Philosophy

- Tests are coordinated by the Systems Integration and Test Branch (Richard Foss) which is part of the Systems Engineering Competency.
- Test articles and test requirements are provided by each project, and therefore can vary.
- Actual requirements are based on NASA STD-7002 (Payload Test Requirements), the GSFC General Environmental Verification Specification (GEVS), MIL Standards, or RTCA (aircraft).



LaRC Testing Summary

- Is thermal balance testing performed before thermal vacuum testing ?
  - Prior to thermal cycling allows adjustment of the thermal cycle test levels based on thermal balance results (CERES 1996)
  - After thermal cycling allows flexibility in the test durations … it can vary
- Describe thermal vacuum test goals
  - Verify hardware workmanship, design margin, and acceptability at extreme temperature levels
  - Evaluate system performance under simulated vacuum and temperature conditions
- Describe thermal balance test goals
  - To replicate, as close as reasonably possible, the flight thermal environment of the test article
  - Produce thermal data set sufficient to verify Thermal Math Model (TMM) accuracy

Soak Criteria, Transition Rates, and Thermal Stability

- Temperature soaks criteria
  - Hardware specific, > 4 hour dwell time after thermal stabilization is typical for earth observing instrument
- The rate of transition during warming or cooling
  - Subject to pre-test analysis and hardware limitations, will typically transition as quickly as possible to reduce cycle time. Often limited to < 10 C/hour (CERES)
  - Often will overshoot target temperatures on external surfaces to hasten internal temperature response
- Contamination
  - First thermal cycle is HOT to complete contamination bakeout and record initial TQCM levels. Final hot plateau is used to verify TQCM readings are at an acceptable outgassing level
- Stabilization criteria
  - Start TVAC plateau when temperatures are within 2 C of target and vary less than 1 C per hour for TVAC
  - Start thermal balance plateau when temperatures are stable within 0.5 C per hour over a minimum of a one hour period

Heater Verification Philosophy

- Two general methods used for heater verification:
  - Maximum heater power (if applicable) during hot survival cases and minimum heater power during cold survival cases.

(1) Perform thermal testing at 10 degrees below cold temperature setpoint of each heated device.

OR

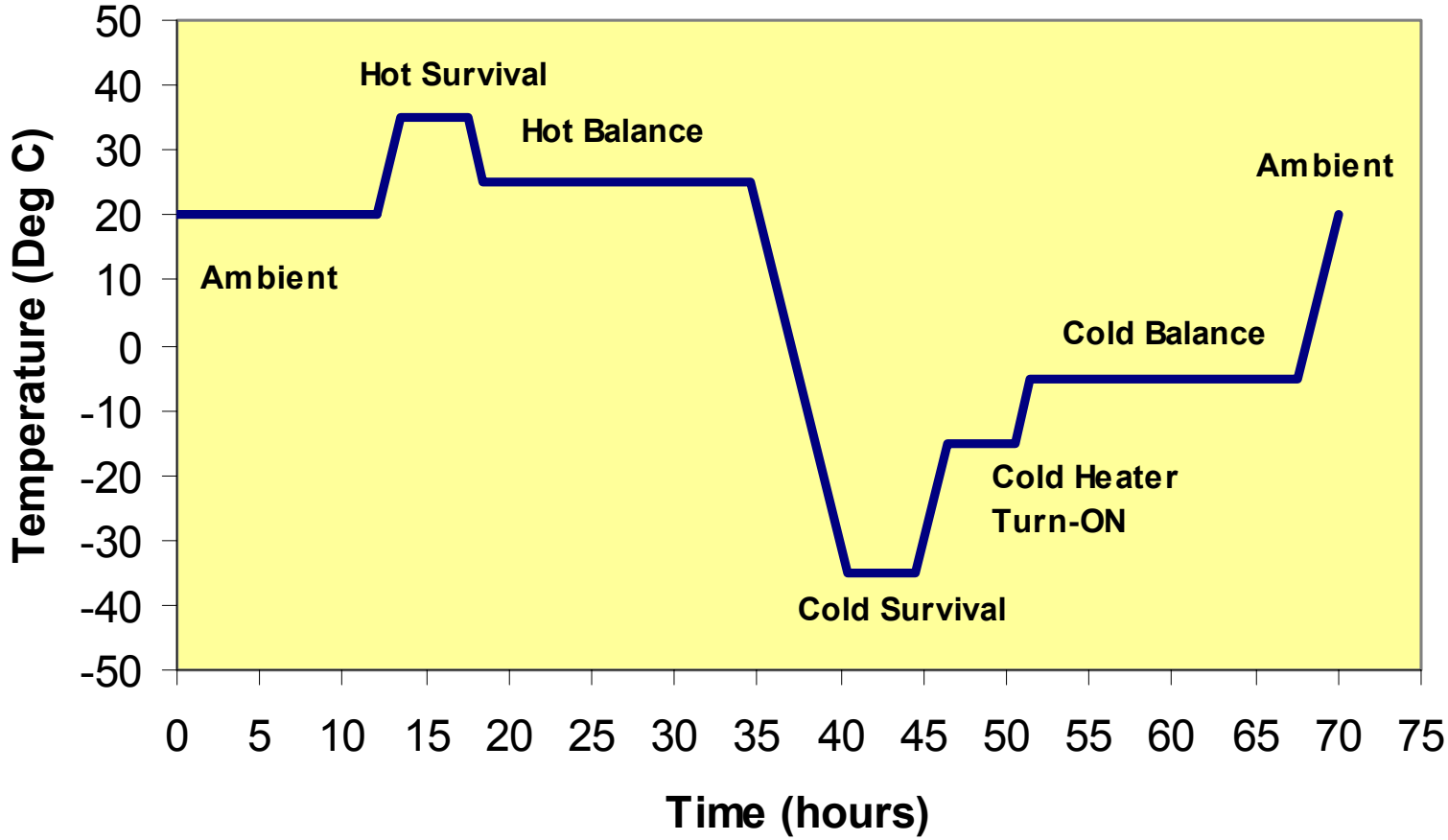
(2) Verify heater duty cycle is <70% (or >30% margin) at 5 degrees below cold turn-on limit and at the minimum heater voltage.

LaRC TVAC Summary

Vacuum or Air	Thermal Cycles	Dwell Times at Extremes	Thermal Margins	Assembly Level
Vacuum < 10^{-5} Torr	4	> 24 hours	Thermal predictions + 10C margin	Payload
Vacuum < 10^{-5} Torr	8	Varies (4 to 16) to achieve >100 hours total	Thermal predictions + 10C margin	Instrument
Vacuum < 10^{-5} Torr	> 10	> 4 hours	Thermal predictions + 10C margin	Component
Ambient Pressure	Varies	Varies	Not meant to substitute for vacuum testing. Add TBD margin to qualifications limits for air vs. vacuum difference.	Component

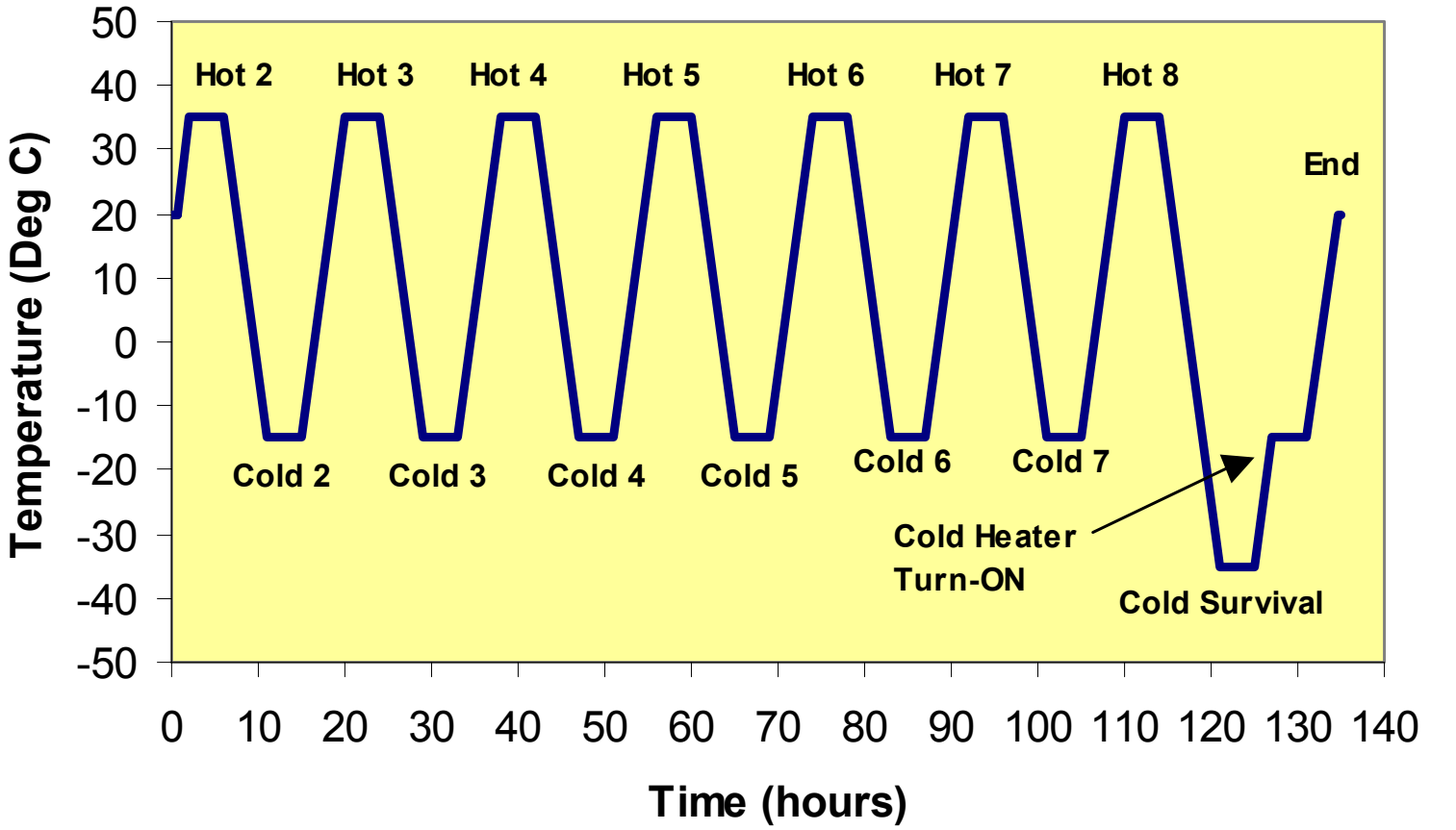
Thermal Balance Test Profile

- Sample from CERES Instrument (TRMM Mission) in 1995
- Typically performed as part of the full TVAC test



Thermal Vacuum Test Profile

- **Sample from CERES Instrument (TRMM Mission) in 1995**
- **Thermal Balance is cycle #1. TVAC includes 7 cycles to achieve a total of 8 vacuum cycles.**



Example LaRC Test Case

- Example Test Case
  - Power distribution box dissipates 36 watts and is predicted to be -5C and 34C for a LEO 5-year orbit.
  - Safemode (8 watts) requires heaters (-15C to -5C survival at 24V to 32V). Operational limits are -20C to 45C and Survival limits are -20C to 50C.
- LaRC Testing Approach
  - Component-Level Tests: 10 cycles (4 hrs dwell) at –15C to +44C limits. Limited operation at plateaus for checkout.
  - System-Level Tests: 8 TVAC cycles (4 hrs dwell), plus one TB cycle (16 hrs dwell), at –15C to +44C limits. Continuous operation during TVAC and TB cycles.
  - Survival heaters verified at –20C to have >30% margin (<70% duty cycle) at 24V (minimum) during safemode. Verify cold turn-ON at -15C and turn-OFF at –5C.